

What's in a Solution—The Cup Doesn't Runneth Over!

This demonstration will help students understand how the solute particles become evenly distributed throughout the solution.

Application	Solutions • Solvation • Solution Process
Theory	<p>Solutions are made by dissolving or distributing the particles of one substance (called the solute) uniformly through the particles of another substance (called the solvent). It is said that the solvent dissolves the solute since the solvent is the substance in greater amount. A spoonful of salt dissolved in a beaker of water is an example of a solution. The salt is the solute whereas the water is the solvent.</p> <p>The solution process involves solvent molecules pulling apart the relatively large crystal (or concentration of liquid or gas) of solute. As the crystal breaks apart, the particles become so small that they become invisible to the eye. If the solute particles are smaller than the solvent particles, they are able to fill some of the space between the solvent particles. If the solvent particles are smaller, then they fill the spaces between the solute particles. In both cases the final volume of the solute and solvent will be slightly less than the additive volumes. This explains why adding sugar to a full cup of hot tea will not cause the cup to run over. This difference can be used as an estimate of the space found between the particles of a substance.</p>
Materials	<p>Graduated cylinder, Pyrex®, 250-mL</p> <p>Hot tea, 200 mL</p> <p>Sugar cubes, 2</p> <p>Metric ruler</p> <p>Stirring rod</p> <p>Graduated cylinder, 500–1000 mL</p> <p>Large marbles, 25 mm in diameter, 20</p> <p>Small beads, 2–4 mm in diameter, 250 mL</p> <p>Light box</p>
Safety Precautions	Use caution when working with hot liquids to prevent chances of scalding.
Demonstration	Fill a 250-mL graduated cylinder with about 200 mL hot tea. Have a student observe the exact volume for the class. Invite a student to use a ruler to measure the volume of a sugar cube (Domino Dots™ are about 1 cm ³). Add two sugar cubes to the tea. Record the change in volume (the volume should have increased). Use a stirring rod to dissolve the sugar cubes. Record the change in volume. The final

volume should be the same or close to what the original volume was.

As an analogy, fill a 500- or 1000-mL graduated cylinder with about 20 large marbles. The marbles will represent the hot tea. Record the volume of the marbles as the highest point they reach in the cylinder. Add the small beads a little at a time. Point out that the volume of the “solution” has not changed yet since the “solute” (beads) has not filled the spaces found between the “solvent” (marbles) molecules. Keep adding the solute until the total volume begins to increase.

Disposal

Reuse the marbles and beads year to year. The tea may be flushed down the drain.